

THE WESTERNPORT BAY ENVIRONMENTAL STUDY

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ABSTRACT: From 1962, local government, and the Government of Victoria, advocated extensive development of Westernport Bay as a port and for new industries, with little recognition of the possible environmental consequences. The large labour and consumer market of Melbourne is nearby, and the region central to the entire market of southeast Australia. Only Westernport on the Victorian coast and a small number of other locations on the entire Australian coast possess a combination of qualities and resources necessary to many industries. In addition, the area is a major recreation outlet for Melbourne and contains a rich variety of animals and plants. The resources of Westernport Bay are linked into a system such that the value of each resource is related and often dependent upon the maintenance of the others. That is why, with multiple pressures for exploitation of Westernport, it is essential that development and conservation go hand in hand.

By 1970 the concept of a major multidisciplinary environmental study was accepted by all concerned and the outline of its form established. The overall responsibility for the Study is lodged in a four man Executive Committee chaired by A. Dunbavin Butcher, Deputy Director of the Ministry for Conservation. The three remaining members represent the Westernport Regional Planning Authority, the Division of Ports and Harbors of the Victorian Department of Public Works, and industry. Of the current budget of \$1.535 million, \$400,000 is a contribution from industry. A Study Advisory Committee chaired by Professor J. M. Swan, Pro-Vice-Chancellor of Monash University, reviews proposed technical projects. A Review Committee chaired by Sir John Knott reports directly to government.

The Study consists of 43 individual projects: 7 land based investigations, 26 marine studies, 6 social and economic studies and 4 mathematical modelling projects. Research projects and investigations were initiated early in 1973 and progressively since. The final report of this phase of the Study is due at the end of the first two years, namely, as soon after December 31, 1974 as possible.

INTRODUCTION

Westernport Bay is one of those historical misnomers, since it is actually the eastern of the two major bays in the Melbourne region. It was named by that intrepid physician George Bass, who discovered it in 1798 when he sailed south from Botany Bay in an open whaleboat. Warneke (1968) reports that within a few months of Bass's return to Sydney, sealing expeditions were leaving for Bass Strait and Seal Rocks at the entrance to the Bay. In 1801 Grant conducted further investigations of the Bay. Before departing, he planted Victoria's first grain crops on Churchill Island. Mapping and exploration of the coast and vicinity were carried out in later years by Barrallier, Caley,

Robins, Oxley and Tuckey (Bowden, 1970). In addition, in 1802 a French expedition commanded by Captain Hamelin entered and charted the Bay, naming the northern island 'Ile Française', now French Island.

After this initial burst of interest, the area was left to the sealers who gathered in Bass Strait from all over the world. Seal Rocks yielded a regular harvest and some of the sealers lived periodically on Phillip Island (Gunson, 1968).

In 1826 the visit of the French ships *L'Astrolabe* and *L'Australie* coincided with a period of British fears that the French would claim parts of Australia. To forestall any French ambitions, a settlement was established at Corinella, but soon abandoned, in 1828. It is now believed that

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this visit of the French to Australia and Westernport Bay was for scientific reasons.

Batman and Fawcner settled in what is now the Melbourne area in 1835 and permanent settlement in the Westernport region began during the late 1830's and early 1840's. Cattle 'runs' gradually spread from Melbourne through Dandenong and Frankston (Gunson, 1968).

DEVELOPMENT OF THE WESTERNPORT REGION

Agricultural development of the Westernport region expanded and intensified in later years with small towns springing up at strategic points (see Fig. 1). Metropolitan Melbourne also expanded, and extended towards Westernport Bay.

Ultimately it was as a recreation area that Westernport became best known. Although Phillip Island with its unique fauna is a true international tourist attraction, it is the Mornington Peninsula that has become the major recreation outlet for metropolitan Melbourne. Separating Port Phillip Bay and Westernport, and located immediately to the south-east of the metropolis, the Peninsula is an area of great natural attraction with a variety of recreation resources. Its landscapes form a mosaic of hill and vale, wood and pasture; its beaches range from the safe sandy inlets of Port Phillip Bay to the wave-swept surf of the Gunnamatta-Portsea area. A third of the houses on the Peninsula are holiday homes and some 150,000 people use the area as their main source of recreation during the peak summer months.

Both Port Phillip Bay and Westernport are extensively used by amateur fishermen, yachtsmen, swimmers and power boat enthusiasts and Westernport also supports a commercial fishing industry. The Bay is fringed with small towns—San Remo, Corinella, Tooradin, Warneet and Hastings—which have in the past been almost totally dependent upon the fishing industry.

Westernport Bay has long been recognized as a fine port with deep, sheltered anchorage, but it was adjoining Port Phillip Bay which had become Victoria's major commercial and industrial port. Now with a dramatic increase in deep draught shipping, particularly for industrial cargoes, the importance of Westernport has increased. No other harbor on the Victorian coast, and few in Australia, can match its deep sheltered waters. Almost completely landlocked, its depth at the entrance exceeds 33 m, dropping to a minimum at low water of 15 m at berthing points within the Bay.

HISTORICAL BACKGROUND TO THE STUDY

In 1960 some people living generally in the

Mornington Peninsula area and anxious to see the abundant resources of Westernport further developed, formed a Westernport Development Committee. This was followed, 1962, by a meeting with neighbouring shires convened by the Hastings Shire Council to discuss the planning and development of Westernport Bay as a deep water port (Anon., 1972).

A number of factors were recognized as adding to Westernport's value as an industrial port. In the vicinity of Hastings, the deep water channel is flanked on both sides by large tracts of flat land suitable for heavy industrial development. It is close to the Melbourne-Dandenong-Berwick axis, where the thrust of Melbourne's growth has been greatest. Similarly, it is close to the Melbourne-Gippsland axis with its rich resources such as the extensive brown coal deposits in the Latrobe Valley and the gas and oil in Bass Strait.

In the middle sixties local governments, and the Government of Victoria, were advocating extensive development of the port and of new industries, and there was pressure, with little recognition of the possible environmental consequences, for major reclamation of the tidal flats of the Bay. The large labour and consumer market of Melbourne is nearby, and the region is central to the entire market of south-east Australia. It is also served by land transport connections.

In 1962 the Westernport Joint Advisory Planning Committee was formed and an Act of Parliament passed permitting the establishment of an oil refinery at Crib Point. In later years approval was given for the construction of a gas fractionation plant and steelworks north of Hastings.

By 1970 three major industries, a refinery, a crude oil and low pressure gas export facility, and a cold reduction mill, as the first stage of a proposed integrated steelworks, were established or in the process of construction on the western shore of the North Arm. The two petroleum industries are served by channels and port facilities accommodating tankers up to 100,000 Dwt. Both wharves are owned by the State of Victoria, while the raw materials for the cold reduction plant are handled on roll-on, roll-off berths built by the industry concerned. The Acts passed to facilitate construction of two of the industries allows them to carry out reclamation on the Bay shore and some areas where mangroves existed before have already been reclaimed.

Industry is competitive, and minimal transportation costs an integral part of success. Many of the industries basic to Australia's economy could not exist without close access to deep water

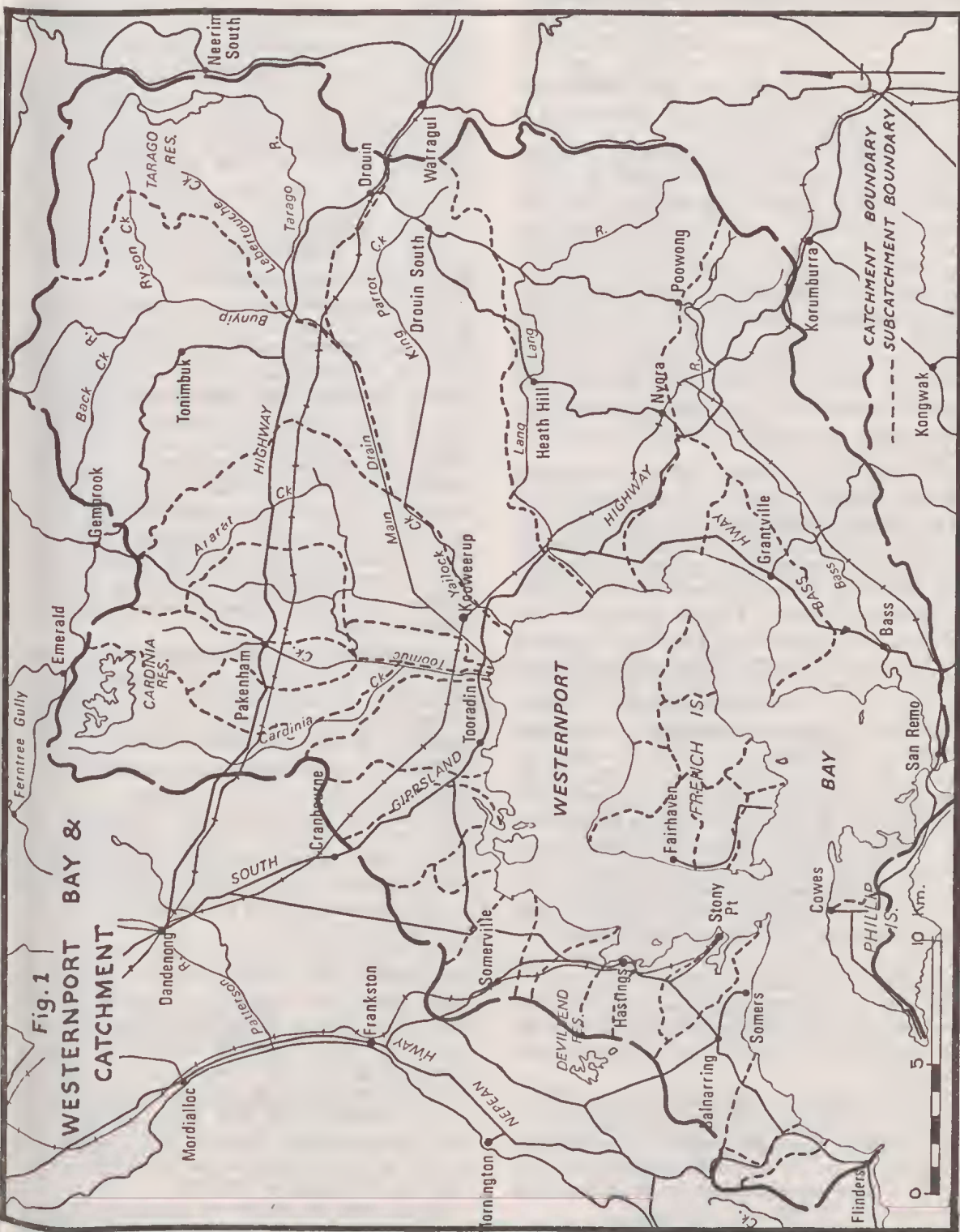


Fig. 1—Westernport Bay and the Adjacent Catchment (Scale 1: 500,000).

and the economies of deep draught cargo shipping. Westernport meets these essential demands: few other locations around the entire coastline of Australia do so. When other factors of markets, labour, land quality and availability and raw material sources are analysed also, Westernport is found to be highly suitable for development as an industrial port complex.

During 1969, two organizations of great significance for the future of Westernport Bay were formed. These were the Westernport Regional Planning Authority and the Westernport Bay Water Pollution Committee. There was recognition that perhaps the most important feature of the resources of Westernport is that they do not exist in isolation but are linked in an ecological system such that the value of each resource is related and often dependent upon the maintenance of others (Butcher, 1970). This is why, with multiple pressures for exploitation of Westernport, it is essential that development and conservation go hand in hand.

By 1970, after initiatives by the Westernport Water Pollution Committee, the concept of a major multidisciplinary study was accepted by all concerned and the outline of its form established. The overall responsibility for the Study was lodged in a four man Executive Committee chaired by A. Dunbavin Butcher, Deputy Director of the Ministry for Conservation. The three remaining members represent the Western Port Regional Planning Authority, the Division of Ports and Harbours of the Victorian Department of Public Works, and an industry representative. It has been averred that the Study has unique features: perhaps of greatest moment is the fact that of the current \$1.535 million, \$400,000 is a contribution from industry. However, the Study is independent and, subject to the administrative policy of government being generally adhered to, all policy decisions and financial approvals are matters for the Executive Committee. The Executive Committee is backed by a larger Study Committee, chaired by Professor John Swan, Pro-Vice-Chancellor of Monash University. This has a major function of commenting on proposed tasks prepared by ad hoc sub-committees and, since the advent of the Core Group, those prepared by this Group also.

Recently a Review Committee was appointed with the function of acting outside the already existing bodies to assess progress and objectives of the Study and to report to Government. The Review Committee is chaired by Sir John Knott and these are its terms of reference:

'To review Study objectives by making impartial assessment of programs, agency, consultant and

university contractor activity and advising upon these.

To report to Government on the organization, operation and effectiveness of the Study'.

Early in the development of the Study it was concluded that the demands of a multidisciplinary undertaking required direction and co-ordination. The Core Group concept evolved and was accepted. This is, as is the Study itself, a group composed of biological, physical and social scientists, engineers and administrators. The Core Group is intimately involved in each of the research and investigation projects, and is responsible to the Executive Committee.

The Westernport Bay Environmental Study is hence a co-operative and collaborative multidisciplinary effort consisting of basic and applied research activities designed to develop comprehensive knowledge and understanding of the Bay and its catchment. The resulting balanced approach to the future of the region should permit those with statutory responsibilities and others concerned to assess and evaluate most, and ideally, all of the relevant factors which impinge on the environmental viability of Westernport Bay. Fig. 1 shows Westernport Bay with the external boundaries of the catchments which flank the Bay, together with the boundaries of the component sub-catchments.

Co-operation and collaboration is demonstrated in a variety of ways, of which perhaps the most outstanding is that the Study is jointly financed by government and industry. The original budget, approved in 1972, amounted to \$1 million: \$300,000 provided by industry and \$700,000 by government. Early in 1973, a budget review was undertaken to update scientific information and take into account other changes such as inflation. This resulted in approval of a new budget of \$1.535 million to which industry and government contributed on much the same basis as was agreed for the original budget.

The Study was originally conceived as a five year activity, but for a number of reasons the initial phase was modified to cover a two year span, after which a reassessment of requirements was to be made. Thus the contracts awarded to university groups and consultants, and the task specifications approved for the studies and research undertaken by both State and Commonwealth governmental agencies, have deadlines for a final or major report to be submitted no later than the third quarter of 1974.

Shortly after the Study was initiated in January, 1973, the Premier of Victoria made a statement (February 13) concerning the future of Morning-

ton Peninsula and Westernport. Of the five points of the statement the first was:

'1. No permits for major industrial projects in the Westernport area (including French Island) will be granted while the Study is in progress (at least for two years)'. (The 'Study' is the Westernport Bay Environmental Study.)

By this action the requirement for the submission of a report at the end of the two year Study was re-emphasized.

THE WESTERNPORT BAY ENVIRONMENTAL STUDY PROGRAM

The Study program consists of a set of co-ordinated projects concerned with activities and characteristics of the catchment area of the Bay and the Bay itself, as they affect environmental quality (see Fig. 2). A Critical Path Program has been in operation since the Study was initiated and the network has been assessed a number of times. Initially, the Study consisted of 23 tasks, but since that time activities have expanded. The following is a brief outline of the individual tasks and their objectives.

1. LAND BASED STUDIES

Land based studies are designed to obtain basic information and understanding of the physical

characteristics of the catchment, its soils, geology, hydrology and climatology. The latter information is to be obtained from historical records and current measurements.

1.1 GEOLOGY

1.1.1 Description of Geology and Hydrology of the Bay: A comprehensive bibliography of the available information is being prepared by the Victorian Mines Department and the State Rivers and Water Supply Commission as a basis for a review of the geology and hydrology of the Westernport Region.

1.1.2 Seismic Survey: A sparker seismic survey of Westernport Bay has been conducted by the Commonwealth Bureau of Mineral Resources in co-operation with the Victorian Mines Department to delineate the subsea extent of aquifers in the area and to locate any sea bottom outcrops of these aquifers where salt water intrusion or freshwater loss may be occurring.

1.1.3 Gravity Survey: This survey is being carried out by the Geology Department, University of Melbourne in co-operation with the Geological Survey of Victoria. It will detect subsurface density inhomogeneities which can be used to determine the regional extent of the various geological features of the Westernport Sunklands.

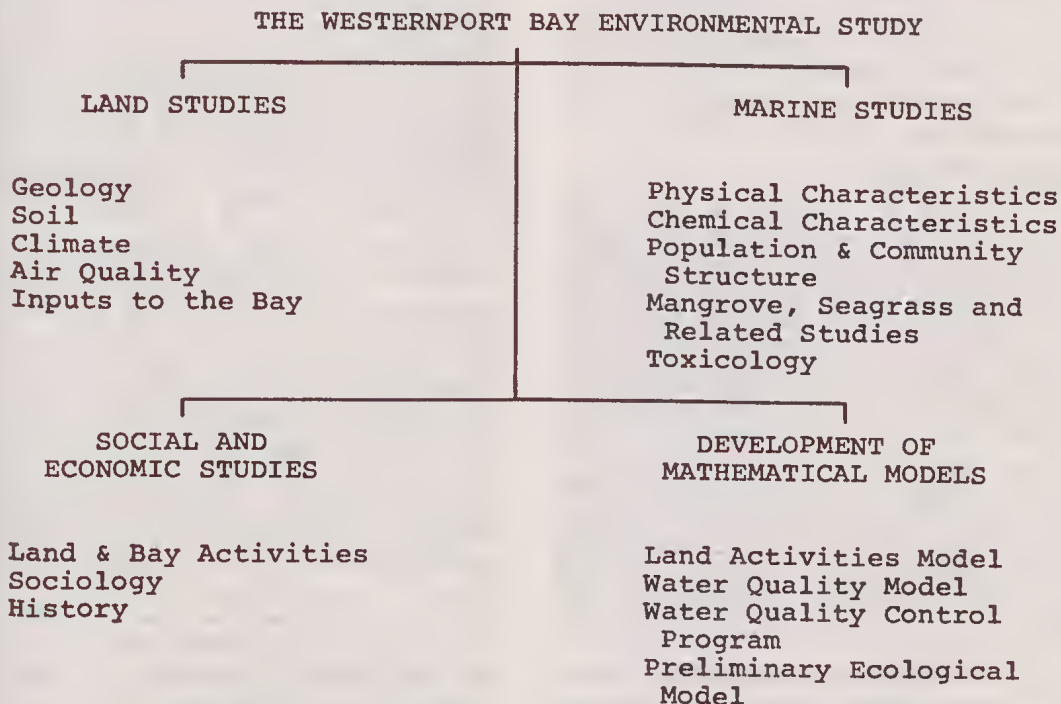


FIG. 2—Organization of the Westernport Environmental Study research program.

1.2 SOIL

1.2.1 Soil Reconnaissance Survey: A survey of the soils of the Westernport catchment is being carried out by the Soil Survey Section of the Victorian Department of Agriculture in association with the State Rivers and Water Supply Commission. It will determine their suitability for forest, agriculture and urban use, as well as physical and chemical properties affecting run-off and groundwater flow.

1.3 CLIMATE

1.3.1 Climate Survey: This involves the collection, collation and analysis of climatic records and involves the Commonwealth Bureau of Meteorology, the State Rivers and Water Supply Commission and the CSIRO Division of Atmospheric Physics.

1.4 AIR QUALITY

1.4.1 Air Quality Baseline Investigation: This project is to determine the air pollution potential in the Westernport region with particular emphasis on the areas proposed for industrial development.

1.5 INPUTS TO THE BAY

1.5.1 Input Stream Sampling and Gauging: This project is being carried out by the Victorian Departments of Health and Agriculture and the State Rivers and Water Supply Commission. Its aim is to assess the average and extreme hydraulic load of selected chemicals entering the Bay with the present pattern of land use, and to establish techniques to predict the loadings from other patterns of land use within the catchment.

2. MARINE STUDIES

Marine studies are designed to obtain the maximum information and understanding possible under the constraints of time and resources about the physical, chemical and biological regimes of the Bay. They constitute collaborative field sampling and collection program, laboratory analysis and various research activities. These range from categorization of archival biological material collected by a large number of people for many years and stored in the National Museum of Victoria to 'flow through' toxicological studies conducted by the Marine Pollution Studies Group, Victorian Fisheries and Wildlife Division, designed to ascertain the lethal and sub-lethal effects of toxic materials which could be introduced into the Bay.

2.1 PHYSICAL CHARACTERISTICS OF THE BAY

2.1.1 Hydrographic and Hydrodynamic Characteristics Study: This project aims to obtain basic

hydrographic and hydrodynamic data for calibration and verification of the Water Quality Model and to provide a comprehensive description of water movement in the Bay. The Ports and Harbors Division, Victorian Department of Public Works, is conducting the work.

2.1.2 Drift of Surface Residing Materials Study: This aims to describe the patterns of surface winds in the region and to develop, as an adjunct to the Water Quality Model, a technique to determine the likely frequency of deposition on shores of the surface residing materials discharged from any potential source. The project is being carried out by CSIRO, Division of Atmospheric Physics.

2.1.3 Preliminary Sediments Survey: A preliminary assessment of the patterns of sediment distribution in the Bay has been made by the Geology Department, University of Melbourne.

2.1.4 Sediment Movement and Bottom Deposits: Bottom current and sediment transport are to be measured at selected localities, and also bottom drift studied, to predict the occurrence of sediment movement and determine mode of sediment transport. The project will be conducted by the Geology Department, University of Melbourne.

2.2 CHEMICAL CHARACTERISTICS OF THE BAY

2.2.1 Nutrient and Other Chemical Studies: This program has been initiated to determine the concentrations of nutrients, such as compounds of N, P and Si, and other chemical substances of environmental importance, for example, dissolved oxygen, chlorophyll a, and their seasonal variations in the Bay waters. A Marine Chemistry Unit has been set up within the Victorian Division of Agricultural Chemistry to make these determinations.

2.2.2 Environmental Monitoring of Toxic Materials: The objective of this program is to investigate the current distribution and concentration of pesticides, PCB's (polychlorobiphenyls) and heavy metals (Zn, Cd, Hg, Pb and Cr) in sediments, phytobenthos, zoobenthos, total plankton, water, fishes, birds and mammals at major river, municipal and industrial effluent discharge points in Westernport Bay. It is a joint project, involving the Arthur Rylah Institute and the Marine Pollution Studies Group of the Fisheries and Wildlife Division, and the Marine Chemistry Unit.

2.2.3 Hydrocarbon Investigations: This project aims to provide a preliminary survey of the current concentrations of petroleum hydrocarbons which exist in the biotic and abiotic components of the Bay. It is being carried out at the Study's

Crib Point Regional Laboratory in association with the Marine Chemistry Unit.

2.2.4 *Chemical Data Comparison Study*: A private consultant is gathering chemical data on marine or estuarine areas in other parts of the world as a basis for comparison with Westernport Bay.

2.3 POPULATION AND COMMUNITY STRUCTURE

2.3.1 *Field Survey of Fish Populations*: This project was initiated to establish baseline data on fish populations in the Bay, including characterization of natural variation against which future changes can be assessed. The work as well as that for the following Studies (2.3.2, 2.3.3, 2.3.4) is being carried out in the Marine Pollution Studies Group, Fisheries and Wildlife Division.

2.3.2 *Zooplankton Population Studies*: The determination of existing types, abundance and distribution of zooplankton in Westernport Bay is in progress. The information will be used in a similar manner to that described below for Zoobenthos Invertebrate Studies.

2.3.3 *Zoobenthos Invertebrate Studies*: This project has the following aims:

1. To provide information as to the present condition of the Bay by surveying the invertebrate population in order to develop estimates of the density and diversity of this population.

2. To obtain knowledge of the distribution of benthic fauna and any relevant physicochemical parameters which are sufficiently detailed and quantified to provide a baseline against which changes in faunal composition can be evaluated.

2.3.4 *Study of Archival Benthic Material*: The results of this project will assist in the definition and characterization of the marine invertebrate fauna of Westernport Bay by correlating the records and collections lodged in the National Museum of Victoria archives over the past eighty years with new information.

2.3.5 *Avifauna Investigation*: This project involves the collection of historical and current data on the species associated with the various habitats in the area, and as possible, to determine the seasonal variation in habitat usage and abundance of species. The work is being carried out by collaboration between the Arthur Rylah Institute, Fisheries and Wildlife Division, Monash University and various ornithological groups.

2.3.6 *Exploratory Investigation of Feeding Ecology and Behaviour of Shorebirds in Westernport Bay*: This project involves investigation of the food intake of shorebirds in the Bay and evaluation of different areas as food sources. It is being carried out by a staff member from the

University of Durham (England) on sabbatical leave at Monash University.

2.3.7 *Preliminary Investigation of the Effect of Dredging and Dredging Spoil*: This project involves evaluation of the effects of past dredging and spoil disposal in Westernport Bay, and aims to indicate whether or not further investigation is needed into the effects of dredging operations on the biological environment of the Bay. It is being undertaken by a private consultant.

2.4. MANGROVES, SEAGRASS AND RELATED STUDIES

2.4.1 *Study of Coastal Dynamics*: Historical data indicates that sedimentation, erosion and other factors have caused substantial changes to the coastline of Westernport Bay. This study, which has been carried out in the Geography Department of the University of Melbourne, is designed to provide one input for the development of guidelines for management of future coastal changes.

2.4.2 *Classification and Mapping of Peripheral Vegetation*: The survey and mapping of the coastal vegetation of Westernport Bay and the determination of the vegetation units or plant associations that exist in this region is being conducted in the Botany Department of Monash University.

2.4.3—*Mapping of Seagrass Communities*: Basic information as to the extent and location of the seagrass communities in Westernport Bay is being obtained by private consultants who are mapping these communities. This information is needed by the other studies concerned with the quantitative evaluation of the biological significance of the mangrove, saltmarsh and seagrass communities.

2.4.4 *The Determination of the Role of the Mangrove and Seagrass Communities in Nutrient Cycling*: The purpose of this investigation is to examine the cycling of nutrients within and between plant communities, water and detritus in Westernport Bay. It is being carried out by the Botany Department of the University of Melbourne.

2.4.5 *Study of the Role of Macrofauna in Seagrass Communities*: This project aims to concentrate on a limited number of representative areas and carry out detailed studies on these areas to determine the role of the seagrass macrofauna in the Bay ecosystem. Staff at the Zoology Department, University of Melbourne, are planning and carrying out this investigation.

2.4.6 *Marine Bacteria Investigation*: This project aims to investigate the role of bacteria in

controlling the rate of breakdown of marine organic matter and the cycling of nutrients in Westernport Bay. (Carried out in parallel with a similar investigation in Port Phillip Bay.) It is planned to carry it out in the Microbiology Department, University of Melbourne.

2.4.7 Study of the White Mangrove (*Avicennia marina*): The objective of this investigation is to determine the environmental factors controlling growth and survival of the White Mangrove (*Avicennia marina*) in Westernport Bay. It has been undertaken by the Botany Department, University of Melbourne.

2.4.8 Productivity Studies: This work involves a study of carbon flux through the Bay system in relation to nutrient cycling. Production of organic carbon by seagrasses and phytoplankton is being compared, and an assessment of loss through respiration versus consumption in situ, in open water, sediments, loss to beaches and open ocean is being made. Staff of the Marine Pollution Studies Group, Fisheries and Wildlife Division, are conducting this investigation, as well as the two immediately following (2.5.1, 2.5.2).

2.5 TOXICOLOGY AND RELATED STUDIES

2.5.1 Fish Toxicology Study: The fish toxicology program is designed to establish the 'safe' ambient concentrations of selected heavy metals for the species of fish in Westernport Bay that are important for commercial, recreational and/or ecological reasons. It involves both static and flow-through bioassay experimentation.

2.5.2 Invertebrate Toxicology Study: In this work the bioassay technique is being used to establish 'safe' concentrations of toxicants for invertebrate marine animals which occur in Westernport Bay.

2.5.3 Heavy Metal Accumulation in Biological Materials: This work involves the collection of phytoplankton from Westernport Bay and the analysis of these collections for heavy metals (Cu, Zn, Pb and Cd). In addition, laboratory cultures of *Ditylum brightwellii* are being made to determine the rate of uptake of the above heavy metals by this organism. The work is being carried out by the Botany Department, University of Melbourne.

3. SOCIAL AND ECONOMIC STUDIES

Westernport Bay and its catchment is a complex region. The future of the Bay and the region depends upon the quality of the choices and decisions made in relation to its development. An understanding of the underlying social and economic determinants of such choices is of great importance. The following projects, including the model building efforts, are designed to make a

start in understanding the complex and ecological inter-relationships in the region.

3.1 LAND AND BAY ACTIVITIES

3.1.1 Survey of Existing Land Use: The aim of this investigation is to collect data on existing land use in the Westernport Bay catchment and to arrange this information in a form appropriate for use in the land activities model. This is being carried out by Westernport Regional Planning Authority and private consultants.

3.1.2 Beach Survey: This survey is being carried out by the Core Group and its aims are threefold:

1. To locate the presently used beaches in Westernport Bay.
2. To select representative beaches to be inspected regularly to assess present beach and water quality, present use, and any relations between these.

3. To gather data to form a basis for monitoring future changes in beach use and quality.

3.1.3 Forecast of Possible Industrial Development: The objective of this program (undertaken by contract) is to explore the economic probabilities and the types of industries which might locate at Westernport.

3.1.4 Survey of Beneficial Uses of the Bay: The main aim of this survey is to provide sufficient quantitative documentation of both existing and possible future uses of the total study area. This information should facilitate measures to meet public demands and requirements. The survey has been undertaken by the Westernport Regional Planning Authority.

3.2 SOCIOLOGY

3.2.1 Sociological Investigation: The aim of this investigation is to determine attitudes of people to aspects of the existing and projected environment of Westernport Bay and its region. The work is being carried out within the Core Group.

3.3 HISTORY

3.3.1 History of the Study Area: The objectives of this project, which is being carried out by the History Department of the University of Melbourne, are:

1. To establish the pattern of settlement of the Westernport region and discover any influences this had upon community development, transport pattern and use of natural resources.
2. To investigate the pressures, as they developed, from the growth of Melbourne, and from concepts, in particular those from 1960 to the present, of Westernport as a setting for a separate urban-industrial centre.

4. DEVELOPMENT AND APPLICATION OF MODELS

4.1 LAND AND BAY ACTIVITIES

4.1.1 *Land Activities Model:* The aim of this model is to represent the relationships between land activity alternatives, effluent control options and water quality in Westernport Bay and to take into consideration the social and actual costs and benefits of these options. It is intended as a tool to permit exploration of the alternatives and to find a mix of activities which can be defended on broad social grounds, and to provide a basis for a wider consensus in the community as a whole. In the development of the model, the catchment of the Bay was divided into subcatchments and zones as shown in Fig. 1. The model is being developed by private consultants.

4.2 WATER QUALITY

4.2.1 *Water Quality Model:* To develop a mathematical model of Westernport Bay capable of linking discharges from the land to concentrations of several parameters in the Bay. The programs are to solve the basic equations of fluid flow and chemical kinetics at each of the thousand plus grid points throughout the Bay. Private consultants are developing this model. The programs are: 1. Topographic program; 2. Hydrodynamic program; 3. Pollutant transport program; 4. Pollutant decay program; 5. Pollutant Interaction and chemical kinetics program.

4.2.2 *Water Quality Control Program:* This involves an evaluation of feasible alternative schemes for the collection, treatment and disposal of wastewater generated within the catchment. This is being carried out by the State Rivers and Water Supply Commission.

4.3 ECOLOGY

4.3.1 *Preliminary Ecological Model:* A preliminary model of the Bay ecosystem is being developed in the Marine Pollution Studies Group, Fisheries and Wildlife Division, and the Core Group.

PUBLIC INFORMATION

The presentation of the results and conclusions of the Study is of vital importance and, at this stage, the topic is subject to discussion and modification. However, these are current plans for advising the Government, the public and other scientists.

First, a major document, containing a detailed interpretation of the results, conclusions and

advice is to be prepared. Then as an aid to other researchers there will be a compilation of the reports as received from the individual projects. A third document to be reproduced in substantial numbers will briefly describe the ecosystem in pictorial and diagrammatic form and will outline the results and options.

A film, to be produced jointly by the Victorian Ministry for Conservation, the British Broadcasting Corporation and the Australian Broadcasting Commission, is planned. It is believed the film will be distributed overseas as well as in Australia.

In addition, public meetings and addresses to private organizations by Study personnel has assisted in informing the public of the Study's objectives and progress.

CONCLUSIONS

In a Study of this magnitude some avenues of investigation will prove to be of particular importance, and require further work to gain a clearer perception of future environmental implications. However, in other cases all the information needed will be obtained in the period of the present Westernport Bay Environmental Study. We believe that in spite of the time constraints, a substantial body of information will be available for the formulation of the initial environmental management objectives.

The physical, chemical, biological, social and economic environment of Westernport Bay is highly complex. Within the natural environment chemical and biological factors interact in a pattern which varies from season to season, and even throughout individual daily cycles.

Social factors such as recreational fishing, boating and similar activities are superimposed on the ecosystem and influence it. In addition, commercial fishing, industry and urban development all affect the area and thus the nature of the ecosystem. In such a complex situation, future monitoring will be necessary to detect changes and to assure the success of environmental management procedures.

ACKNOWLEDGMENTS

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